Description

Dry-Process Nonwoven Pulp Fabric Composed of United layer Structures

Technical Field

The present invention relates to a dry-process nonwoven pulp fabric which is strong even when it is wetted. More particularly, the present invention relates to a nonwoven fabric used in a wet state, which is suitable for wipers for material use such as floor use, kitchen use or automobile use, for kitchen sheets for cleaning of cooking utensils, wiping of foodstuffs, drip absorption and the like, or for wipers for human use such as face use, hand use or body use. Further, in the present invention, even when the nonwoven fabric is used in a dry state, water exists in these uses in many cases, so that similar effects can be expected. Furthermore, the present invention relates to a nonwoven fabric similarly suitable for hygienic materials such as sanitary goods and diapers, or for medical use.

Background Art

In a dry-process nonwoven pulp fabric which has hitherto been known, a pulp fiber layer is used as a base, and a chemical binder resin such as a polyacrylic ester-based or polyvinyl acetate-based resin is sprayed or applied on a surface layer thereof or impregnated throughout the whole thereof to form

interfiber bonds.

In such a nonwoven fabric, when the binder amount is increased, the resin forms a film to become hard, which causes a reduction in water absorption ability. On the other hand, when it is decreased, not only shedding of pulp fibers increases, but also a decrease in strength, particularly in wet strength, is unavoidable.

Further, a method of imparting a powdery binder resin is conceivable. In this case, however, the number of adhesion points between the pulp fibers and the binder decreases to cause a tendency to increase shedding fibers, although the film is difficult to be formed. It is therefore difficult to produce a dry-process nonwoven pulp fabric excellent in wet strength while securing moderate water absorption properties, decreased shedding of fibers, strength available for practical use and the like.

As a dry-process nonwoven pulp fabric used for absorption insert material use of sanitary goods or for domestic or industrial washing use, there has been proposed a dry-process nonwoven pulp fabric in which the basis weight (METSUKE) of a surface layer composed of only a binder fiber is from 1 to 5 g/m^2, and the amount of the binder fiber contained in an internal layer portion is from 2 to 10% by weight (Published Japanese Translation of PCT Patent Application 2000-504792).

The strength of this nonwoven fabric is sufficient with respect to ordinary strength for hygienic good use such as absorption insert material use of sanitary goods. However, it

is not mentioned at all whether the nonwoven fabric is "strong even when wetted" or not, which is an important point of the present invention. The nonwoven fabric having a technical content within the scope of this published patent is as small as 2 to 10% by weight in the amount of the binder fiber contained in the internal layer portion, so that it can not be said to be strong even when wetted. This brings about a significant decrease in strength in a wet state to be unsuitable for wiping, and therefore is completely different from the intension of the present invention.

Further, there has also been proposed an air-laid nonwoven fabric having a specified tearing strength, which is formed by heat bonding intersecting points of binder fibers (JP-A-2000-345454). However, wet strength in compounding with pulp and water absorption properties are not mentioned at all, and there is utterly no description which suggests the technique as a layer structure of the present invention.

Conventional nonwoven fabrics have the problems as described above.

Disclosure of the Invention

The present inventors have made intensive studies in view of the present state as described above. As a result, the present inventors have discovered that a dry-process nonwoven fabric which is free from the shedding of fibers, sufficient in water absorption properties and strong, particularly sufficient in wet strength, can be obtained by making proper

the basis weight (METSUKE) of heat-bondable synthetic fiber-containing front and back surface layers and increasing the amount of the heat-bondable synthetic fibers contained in an internal layer, thus completing the present invention.

Best Mode for Carrying Out the Invention

The present invention relates to a dry-process nonwoven pulp fabric (hereinafter also briefly referred to as a " dry-process nonwoven fabric") composing united layer structures, which contains heat-bondable synthetic fibers and comprises surface layer portions on both sides in which the synthetic fibers are heat bonded to one another and which has a basis weight of more than 5 g/m^2 to 12 g/m^2, and an internal layer portion in which heat-bondable synthetic fibers and pulp fibers are mixed at a ratio of 20/80 to 60/40% by weight and the synthetic fibers and/or the synthetic fibers and pulp fibers are heat bonded to one another and which has a basis weight of 8 to 240 g/m^2, wherein the front and back surface layers and the internal layer portion are united as a whole by heat bonding of the synthetic fibers to one another, the ratio of a strength in a lengthwise direction to that in a crosswise direction is from 0.8 to 1.2 in both dry and wet states, the ratio of a strength in a dry state to that in a wet state is from 0.6 to 1.1, the water absorption is from 8 to 20 g/g, and the total basis weight is from 20 to 250 g/m^2.

Embodiments of the present invention are illustrated below.

The nonwoven fabric of the present invention composed of a three-layer structure comprising an internal layer containing heat-bondable synthetic fibers and pulp fibers and surface layers containing heat-bondable synthetic fibers, between which the internal layer is sandwiched, and is united by heat bonding.

In the present invention, the heat-bondable synthetic fibers which are a main component forming the surface layers or mixed with pulp may be any, as long as they are melted by heat and bonded to one another, and the pulp is fixed by a network structure caused by these interfiber bonds. Accordingly, the fibers using a polymer having high affinity with the pulp fibers are particularly preferred. Examples thereof include a polyolefin, a polyolefin grafted with an unsaturated carboxylic acid, a polyester, polyvinyl alcohol and the like.

Of these, as the polyolefinic heat-bondable synthetic fibers, there are suitable sheath-core type or eccentric side-by-side type conjugate fibers. The polyolefins constituting the sheath or a peripheral portion of the fiber include polyethylene and polypropylene. The polymers constituting the core or an internal portion of the fiber are preferably polymers having a melting point higher than that of the sheath and unchangeable at a heat bonding treatment temperature. Such combinations include, for example, polyethylene/polypropylene, polyethylene/polyester, polypropylene/polyester and the like. These polymers may be modified within the range that the operation and effect of the

present invention are not impaired. Further, they may be fibrillated fibers. Examples thereof include SWP supplied from Mitsui Chemicals, Inc.

When the heat-bondable synthetic fibers are fine in size, the number of constituent fibers increases. Accordingly, shedding fibers decrease, and the hand feeling also becomes soft. When they are heavy in size, spaces among fibers become large to form a bulky nonwoven fabric, and the scraping effect is also expected. Accordingly, the size of the fibers may be selected depending on their use. However, the fineness thereof is preferably from 0.5 dt to 50 dt, and more preferably from 0.8 dt to 30 dt. Exceeding 50 dt unfavorably results in uncontrollable shedding of the pulp. On the other hand, less than 0.5 dt is unpractical because of poor nonwoven fabric productivity.

Further, the length of the heat-bondable synthetic fibers is preferably from 1 to 15 mm. The shorter fibers result in better mixing properties with pulp, which causes a tendency to form the more uniform nonwoven fabric. However, less than 1 mm results in an approach to a powdery state, so that it is difficult to form the network structure caused by the interfiber bonds. Accordingly, not only shedding of the pulp becomes uncontrollable, but also the strength as the nonwoven fabric decreases. This is therefore unfavorable because of lack of practicability. On the other hand, longer than 15 mm results in an increase in the strength of the nonwoven fabric, but fibers become liable to be entangled with one another during pneumatic

transportation of the fibers in the production of the nonwoven fabric, which unfavorably increases fiber agglomerate defects. Particularly preferred is from 3 to 10 mm.

The surface layer may contain other fibers such as regenerated fibers such as rayon, semi-synthetic fibers such as acetate, synthetic fibers such as polyester, polypropylene, polyamide and Vinylon, and natural fibers such as pulp, cotton and hemp, as well as the above-mentioned heat-bondable synthetic fibers. In this case, the ratio of the heat-bondable synthetic fibers in the surface layer is preferably from 70 to 100% by weight, and more preferably from 85 to 100% by weight. In the case of less than 70% by weight, the possibility that shedding of the above-mentioned other fibers occurs increases, and not only the effect of inhibiting shedding of the pulp in the internal layer portion is reduced, but also the wet strength decreases, which causes a practical problem.

These fibers forming the surface layer are heat bonded, and the pulp is fixed by the network structure caused by these interfiber bonds. The basis weight must be more than 5 g/m^2 to 12 g/m^2. Less than 5 g/m^2 results in the decreased amount of synthetic fibers having water resistance and the decreased number of interfiber bonds. Accordingly, not only sufficient wet strength sustainable for wiping can not be secured, but also an increase in shedding fibers is liable to be brought about. Different from an application in which importance is attached to absorptivity, such a nonwoven fabric is unpractical to use for wipers, kitchen sheets and the

like, because of its easy fiber shedding when used for wiping. On the other hand, exceeding 12 g/m^2 results in too thick a heat-bonded layer having water resistance, leading to insufficient water absorption to the internal layer and hard hand feeling. This is also unpractical. An increase in basis weight results in an increase in strength, but in a reduction in water absorption properties. However, the nonwoven fabric having sufficient water absorption properties, sufficient strength even in a wet state, no shedding of fibers and soft hand feeling can be obtained within the range of the present invention.

Further, the synthetic fibers are contained in large amounts, so that oil is well absorbed and compatibility with oil is good. Accordingly, there is also the advantage that stains are easily removed.

In the internal layer portion, the heat-bondable synthetic fibers and the pulp fibers are united by heat bonding. The heat-bondable synthetic fibers may be the same as or different from those used in the surface layer. As the pulp fibers, pulverized pulp having a length of 0.2 mm to 5 mm is preferred.

As for the mixing ratio of the heat-bondable synthetic fibers and the pulp fibers in the internal layer portion, when the ratio of the heat-bondable synthetic fibers is less than 20% by weight based on the total of the heat-bondable synthetic fibers and the pulp fibers, shedding fibers increase and strength, particularly strength in a wet state, decreases.

Such a nonwoven fabric can be used in an application in which importance is attached to water absorption properties and softness, such as a hygienic material, even when low in strength. However, it is unsustainable for use as a nonwoven fabric for wiping which is an object of the present invention. On the other hand, exceeding 60% by weight results in a decrease in the amount of the pulp fibers contributing to absorptivity, which causes not only lack of water wiping properties and absorptivity, but also hard hand feeling. This is therefore unpractical.

An increase in the ratio of the heat-bondable synthetic fibers results in an increase in strength, but in a reduction in water absorption properties.

It has been therefore difficult for sufficient strength, particularly strength in a wet state, to be compatible with water absorption properties.

The compatibility of these is very important for applications such as wipers and kitchen sheets. Within the ratio range of the present invention, the nonwoven fabric having sufficient water absorption properties and sufficient strength even in a wet state is first obtained. Further, such a nonwoven fabric is small in the amount of shedding fibers, and has such a sufficient strength that it can be washed, squeezed and dried even when soiled, and can be repeatedly used several times. Furthermore, the ratio of the heat synthetic fibers is high, so that the volume is small, and a reduction in thickness is possible. Accordingly, the nonwoven fabric is excellent in handling properties, and also useful for space saving.

In the internal layer, the heat-bondable synthetic fibers and/or the heat-bondable synthetic fibers and pulp fibers are heat bonded to one another. The basis weight of this internal layer is preferably from 8 to 240 g/m^2. Less than 8 g/m^2 results in too small the amount of the pulp, which causes insufficient water absorption properties. On the other hand, exceeding 240 g/m^2 is unsuitable for this application because the whole presents a plate form.

Further, as the whole nonwoven fabric, the front and back surface layers and the internal layer portion are also united by heat bonding the heat-bondable synthetic fibers to one another. Furthermore, it has sufficient heat sealing properties.

Such a nonwoven fabric may be produced by any method, as long as it is a dry-process nonwoven fabric. However, a nonwoven fabric produced by an air-laid method is preferred. The nonwoven fabric produced by the air-laid method is preferred, because fibers forming the nonwoven fabric are randomly three-dimensionally orientated in a longitudinal, width and thickness directions of the nonwoven fabric.

Here, the nonwoven fabric produced by the air-laid method can be obtained in the following manner.

Fibers mainly composed of a specified amount of opened heat-bondable synthetic fibers are conveyed while uniformly dispersing them in an air stream, and the fibers blasted out from a screen having fine pores which is provided on a discharge portion are dropped on a metal or plastic net disposed in a lower

portion to accumulate the fibers on the net while sucking air at an underside of the net. Then, a mixture of the heat-bondable synthetic fibers and the pulp fibers is similarly accumulated on the above-mentioned accumulated sheet. Fibers mainly composed of the heat-bondable synthetic fibers are further accumulated on the resulting sheet.

Then, the whole is heat treated at a temperature at which the heat-bondable synthetic fibers sufficiently exhibit their bonding effect, thereby being able to obtain the dry-process nonwoven pulp fabric of the present invention. In order to allow the fibers to sufficiently exhibit the bonding effect, heat treatment at a temperature 15 to 40°C higher than the melting point of a bonding component of the heat-bondable synthetic fibers is necessary.

In the nonwoven fabric thus produced by the air -laid method, the fibers can be randomly three-dimensionally orientated in a flow, width and thickness directions of the nonwoven fabric. These are heat bonded, so that no delamination occurs. Further, the nonwoven fabric produced by the air-laid method is good in uniformity, so that variations in performance are reduced.

Calender treatment or embossing treatment can also be further conducted as needed.

Further, in the nonwoven fabric of the present invention, the ratio of a strength in a lengthwise direction to that in a crosswise direction must be from 0.8 to 1.2, and preferably from 0.85 to 1.2, in both dry and wet states. When either one

of the strengths is low, a practical trouble is liable to occur.

Furthermore, the ratio of a strength in a dry state to that in a wet state must be from 0.6 to 1.1, and preferably from 0.7 to 1.1. Less than 0.6 results in a nonwoven fabric which is largely decreased in strength in a wet state compared to that in a dry state, that is to say, weakened when wetted. This departs from the intention of the present invention, and a practical trouble occurs. Further, in a wet state, the strength increases by surface tension among the fibers due to the presence of water, and exceeds 1 in some cases. This is within the scope of the present invention. However, the strength usually does not exceed 1.1, unless another means of some kind which bonds in the presence of water exists.

It is necessary that a wiper, a kitchen sheet, a hygienic material and the like to which the nonwoven fabric of the present invention is applied have a moderate water absorption, and the water absorption must be from 8 to 20 g/g, and preferably from 10 to 18 g/g. Less than 8 g/g results in lack of wiping properties and water retention in practical use, which causes a practical problem. On the other hand, exceeding 20 g/g results in too much water content retained by the nonwoven fabric itself, which causes a problem with regard to its handling properties.

The basis weight of the whole nonwoven fabric is preferably from 20 to 250 g/m^2, and can be suitably selected depending on its use.

The nonwoven fabric of the present invention may be united

with another sheet, as long as the intension of the present invention is not impaired. For example, when it is united with a breathable sheet, the breathable sheet is previously placed on a metal gauze in preparing the nonwoven fabric of the present invention, and the fibers are accumulated thereon, thereby being able to easily form a composite sheet.

Sheets to be united include a dry-process nonwoven fabric, a wet-process nonwoven fabric, paper, a spun-bond nonwoven fabric, a melt-blown nonwoven fabric, a plastic net, a perforated film, a split yarn cloth, a rough woven and knitted fabrics, a victoria lawn and the like. However, a sheet composed of a heat-bondable material is preferred, and one having high air permeability is preferred.

In the present invention, it has become possible to inhibit the shedding of fibers and to increase the strength of the nonwoven fabric to such a degree as to be sustainable for wiping use or repeated use without impairing water absorption properties by making proper the basis weight of the front and back surface layers containing the heat-bondable synthetic fiber and increasing the amount of the heat-bondable synthetic fibers contained in the internal layer. Further, the nonwoven fabric having good wiping properties for water and oil, having no delamination and very suitable for wiping use has been able to be obtained. Furthermore, the nonwoven fabric of the present invention has sufficient heat sealing properties, and is similarly suitable for hygienic materials such as sanitary goods or diapers, or for medical use.

In addition, the nonwoven fabric of the present invention is free from a fear of a residual monomer due to the chemical binder resin, so that it is sanitary.

Moreover, no waste water is produced in the production process of the nonwoven fabric, and no monomer of the chemical binder is contained in exhaust, resulting in reduced environmental load.

Examples

The present invention will be illustrated with reference to the following examples, but the invention should not be construed as being limited thereto.

Example 1

Sheath-core type conjugate fibers (F6, manufactured by Teijin Fibers Ltd., 2.2 dt, length: 5 mm) comprising polyethylene terephthalate as a core and polyethylene as a sheath were used as heat-bondable fibers for front and back surface layer portions, and a mixture of 30% by weight of conjugate fibers (Intack, manufactured by Chisso Polypro Fiber Co., Ltd., 1.7 dt, length: 5 mm) comprising polypropylene as a core and copolymer polyethylene as a sheath and 70% by weight of pulp (NB416 Kraft manufactured by Weyerhauser Co.) was used as an internal layer portion to produce a nonwoven fabric at a heating temperature of 145°C by an air-laid method.

The basis weight of the front and back surface layers was 6 g/m^2, and the basis of the internal layer was 33 g/m^2. The thickness was 0.54 mm.

Physical properties such as strengths in a lengthwise direction and a crosswise direction, the ratio thereof, the ratio of a strength in a dry state to that in a wet state and water absorption are shown in Table 1.

The strength and water absorption were measured by the following methods:

(1) Strength: The strength was measured according to JIS L-1913, wherein the width of a test piece was taken as 25 mm, and the clamp distance was taken as 100 mm.

(2) Water Absorption: A test piece of 100 mm × 100 mm previously weighed is immersed in water at 20°C for 1 minute, and then paced on a glass plate inclined at an angle of 45 degrees for 1 minute. Then, the test piece is reweighed, and the water absorption is calculated by the following equations:

① Water absorption per area (g/m^2): The weight of water absorbed is divided by the area of the test piece, and indicated in g/m^2.

② Water absorption per its own weight (g/g): The weight of water absorbed is divided by the weight of the test piece, and indicated in g/g.

Example 2

A nonwoven fabric was produced by the air-laid method in the same manner as with Example 1 with the exception that a mixture of the bondable conjugate fibers and pulp at a ratio of 90/10 was used in the front and back surface layer portions, the basis weight thereof was changed to 8 g/m^2, the ratio of the bondable conjugate fibers to the pulp in the internal layer

was changed to 25/75, and the basis weight thereof was changed to 49 g/m^2.

The thickness was 0.68 mm.

Example 3

A nonwoven fabric was produced by the air-laid method in the same manner as with Example 1 with the exception that the basis weight of the front and back surface layer portions was changed to 10 g/m^2, the ratio of the bondable conjugate fibers to the pulp in the internal layer was changed to 40/60, and the basis weight thereof was changed to 100 g/m^2.

Comparative Example 1

A nonwoven fabric was produced by the air-laid method in the same manner as with Example 1 with the exception that the basis weight of the front and back surface layer portions was changed to 4 g/m^2, the ratio of the bondable conjugate fibers to the pulp in the internal layer was changed to 8/92, and the basis weight thereof was changed to 52 g/m^2.

Comparative Example 2

A nonwoven fabric was produced by the air-laid method in the same manner as with Example 1 with the exception that the basis weight of the front and back surface layer portions was changed to 16 g/m^2, the ratio of the bondable conjugate fibers to the pulp in the internal layer was changed to 70/30, and the basis weight thereof was changed to 23 g/m^2.

Comparative Example 3

An air-laid nonwoven fabric having a basis weight of 58 g/m^2 and composed of only pulp was prepared, and impregnated

with an emulsion of a polyacrylic ester resin to a solid content of 8 g/m^2, followed by drying at a hot air temperature of 130°C to form a resin type air-laid nonwoven fabric.

The physical properties of the nonwoven fabrics obtained in Examples and Comparative Examples described above are shown in Table 1.

[Table 1]

			Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3
Front and Back Surface Layers	Composition	PET/PE Conjugate Fiber (2.2 dt × 5 mm)	100%	90%	100%	100%	100%	Acrylic resin 8 g/m^2 Pulp 55 g/m^2
		Pulp	-	10%	-	-	-	
	Basis Weight	g/m^2	6	8	10	4	16	
Internal Layer	Composition	PP/PE Conjugate Fiber (1.7 dt × 5 mm)	30%	25%	40%	8%	70%	
		Pulp	70%	75%	60%	92%	30%	
	Basis Weight	g/m^2	33	49	100	52	32	
Physical Properties of Nonwoven Fabric	Basis Weight (g/m^2)		45	65	120	60	55	63
	Thickness (mm)		0.54	0.68	1.30	0.78	0.50	0.73
	Dry Strength (N/25 mm)	Lengthwise	11.3	9.3	34.5	5.1	15.0	7.9
		Crosswise	9.9	9.0	33.8	4.7	15.2	6.0
		Ratio (Crosswise/ Lengthwise)	0.88	0.97	0.98	0.92	1.01	0.76
	Wet Strength (N/25 mm)	Lengthwise	9.0	7.9	31.2	2.3	14.8	3.1
		Crosswise	9.2	7.5	30.8	19	15.0	2.5
		Ratio (Crosswise/ Lengthwise)	1.02	0.95	0.99	0.83	1.01	0.81
	Dry-Wet Strength Ratio (Lengthwise)	Wet/Dry	0.80	0.85	0.90	0.45	0.99	0.39
	Water Absorption	g/m^2	538	790	1080	960	385	882
		g/g	12.0	12.2	9.0	16	7	14

Industrial Applicability

The dry-process nonwoven pulp fabric composed of united layer structures of the present invention is suitable for wipers for material use such as floor use, kitchen use or automobile use, for kitchen sheets for cleaning of cooking utensils, wiping of foodstuffs, drip absorption and the like, or for wipers for human use such as face use, hand use or body use. Further, the nonwoven fabric is similarly suitable for hygienic materials such as sanitary goods and diapers, or for medical use.